Recommendations for Monitoring Kittlitz's Murrelets in Icy Bay

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National Park Service photo by Mason Reid

Abstract

Kittlitz's murrelet is a rare, non-colonial seabird often associated with tidewater glaciers and a recent candidate under the Endangered Species Act. We conducted at-sea surveys during summer 2005 to understand the spatial and temporal variation in the abundance of Kittlitz's murrelets in order to develop a long-term monitoring plan for this species. Total abundance (N ± SE; 1317 ± 294) peaked from 3-16 July, but decreased dramatically thereafter. The greatest densities were observed consistently in Taan Fjord along with the majority of fish-holding birds. We conclude that Tann Fjord offers not only suitable foraging conditions, but also proximity to nesting habitat. We recommend a long-term monitoring approach for this declining species in Icy Bay.

Introduction

The Kittlitz's murrelet (*Brachyramphus brevirostris*; hereafter KIMU) is one of the rarest and least understood seabirds in the world. This non-colonial species is most closely related to the marbled murrelet, though these species diverged approximately two million years ago at the beginning of the Pleistocene Epoch *(Friesen et al. 1996)*. The species range likely extends from the Okhotsk Sea, throughout the Bering Sea, to northern southeast Alaska, with highest densities in the northern Gulf of Alaska *(Day et al. 1999)*.

Limited data exist to assess the conservation status of KIMU. The world population of KIMU was recently estimated to be between 9,500 and 26,500 birds *(U.S. Fish and Wildlife Service 2004)*. Based on results of at-sea surveys in four core population areas, KIMU have declined up to 84% (-18% per year) in the last few decades across its range *(U.S. Fish and Wildlife Service 2004)*. What's more, very little is known regarding the ecology and demographic changes in this species. To date, less than 35 nest sites have been found worldwide and thus little information exists to identify suitable breeding habitat and conditions contributing to variation in survival and nesting success. In response to documented declines, the U.S. Fish and Wildlife Service listed the KIMU as a candidate species under the Endangered Species Act in May 2004 *(69 FR 24875 24904)*. Speculated causes include oil pollution, gill-net mortality, and reduced availability of preferred forage fish *(Piatt and Anderson 1996, van Vliet and McAllister 1994)*.

A comprehensive monitoring program is critically important for this species for several reasons. First, the existing data from some of the core areas are characterized by small sample sizes and relatively imprecise estimates. Ascertaining the degree of annual variation in populations within and among areas will contribute to our understanding of population dynamics. Second, a well-developed monitoring design will elucidate insight into habitat characteristics that influence the temporal and spatial changes in KIMU distribution and abundance. Finally, at-sea estimates of demographic parameters, including reproductive rates, will ultimately be necessary to identify areas that support successful breeding and possibly serve as a source population for other declining areas.

The overall goal of this study was to gather information for developing a long-term monitoring plan. Icy Bay, a core population area during the breeding season, encompasses a highly dynamic glacial environment. Designing a successful monitoring program requires information about optimal timing for surveys, spatial variability, and detectability of birds under different survey conditions. Since this species is closely associated with tidewater glaciers and glaciated fjords, it was necessary to consider the implications of monitoring populations in such dynamic glacial environments.

Methods

Icy Bay (60° 01' N, 141° 20' W) is a coastal fjord 68 miles (110 km) northwest of Yakutat, Alaska. Much of the upper bay is part of Wrangell-St. Elias National Park. Icy Bay includes a shallow outer bay, adjacent to the Gulf of Alaska, and a deep inner bay. Four fjords radiate from inner Icy Bay, and each has an active tidewater glacier at its head. Taan Fjord is the only consistently accessible fiord; Guyot, Yahtse, and Tsaa Fjords are typically dominated with ice pack and floes. The entire bay is approximately 93 square miles (240 km^2).

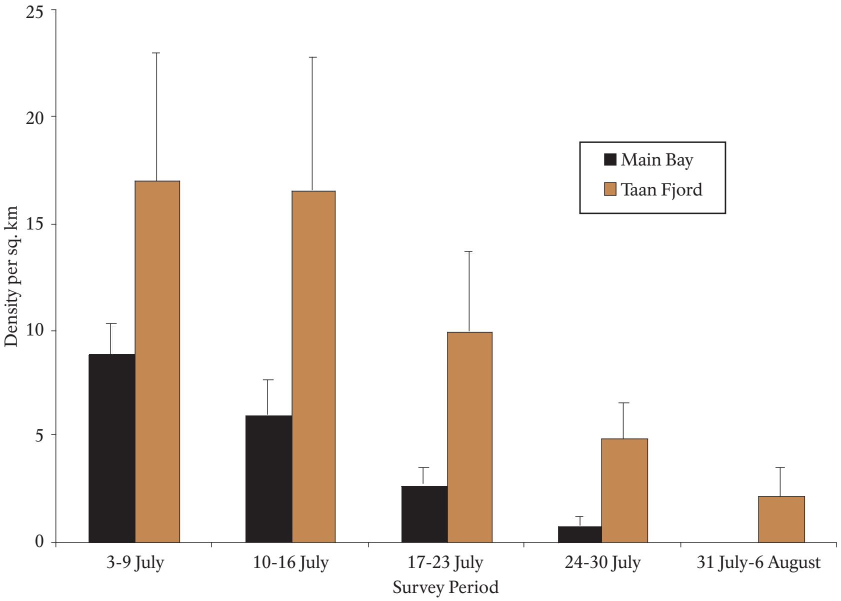

Figure 1. Densities (birds/km²±SE) of Kittlitz's murrelets in Taan Fjord and Main Bay across all five survey periods, Icy Bay, Alaska, 2005.

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At-sea surveys were conducted in Icy Bay from 2 July to 5 August 2005. Two types of transects were established in two sampling strata. Shoreline transects were located within 656 feet (200 m) of shore and were run parallel to shore (total length = 57.5 miles/92.6 km). Pelagic transects (n=17) were perpendicular to shore, located approximately 1.2 miles (2 km) apart, varied in length according to width of the bay or fjord, and ended at 656 feet (200 m) offshore (following *Kuletz and Kendall 1998*). We subdivided Icy Bay into two distinct geographical units—Inner Main Bay (42 mi²/110 km²) and Taan Fjord (9 mi²/24 km²)—because each could be surveyed in one day. Surveys were conducted during five, one-week survey periods. Surveys occurred between 7:00 am and 9:00 pm, using a 18-foot (5.5-m) boat moving at a speed of about 6 mph (10 km/hr). For each observation, number of birds, age category, location (air or water), activity (e.g., flying, on water), and distance from the transect line were recorded. Sea condition (Beaufort scale), precipitation, ice cover (%), and swell (nearest meter) were estimated every 30 minutes or as conditions changed. We recorded data using a voice-activated recording system that was integrated with a GPS unit, which stamped each observation with a location and time (see *Fischer and Larned 2004* for details). Tidal stage (ebb or flood; vertical water) and current strength (horizontal water) were estimated using the same method as Day and Nigro *(2000)* with one exception; relative current tidal strength was multiplied by the maximum tidal height. We estimated density using detection distance data in Program Distance *(Thomas et al. 2006)*.

We then generated an optimal monitoring program using our empirically-derived estimates of variation and detection probability to generate realistic bounds on parameter estimates. We calculated the power to detect a decline in KIMU density of 5 and 10% per year given spatial variation with a coefficient of variation (CV) of 25% and 50% and detection probability variation ranging from a CV of 5-30%. We considered power to detect the trend for a monitoring duration of 5-40 years. For the power estimates, we performed 500 simulation replicates for each combination of rate of decline, spatial variation, detection probability variation, and number of years. We fit a log-linear trend weighted by the inverse of the variance of each density estimate to each simulated survey and determined if that estimated trend was statistically less than zero ($p < 0.05$).

Results

During the five-week period, we recorded 880 *Brachyramphus murrelets,* of which 794 (90%) were KIMU. The overall population estimate (N ± SE) during the peak period (3–9 July) was 1,317 ± 294 birds, decreasing to 68 ± 37 birds by the last survey period (31 July – 6 August). Average group size over all survey periods was 1.65 birds. We found the highest densities of KIMU in Taan Fjord during the first two survey intervals *(Figure 1)*. However, throughout the surveys, KIMU were spatially clumped with concentrations of birds in a few consistent 'hotspots'.

Over the five week period, we recorded 37 fish-holding KIMU. Six were observed during systematic surveys and 31 were recorded opportunistically. We observed all fish-holding KIMU between 5 July and 4 August; most (46%) were observed during the first survey period, decreasing during the remaining intervals (11%, 5%, 24%, and 14%, respectively). Thirty-three (89%) of fish-holding birds were observed in Taan Fjord.

We aged 775 (98%) KIMU as definite after-hatch-year (AHY) birds and 10 as probable AHY birds; only nine were aged as probable HY birds during systematic surveys. We recorded nine additional probable HY birds opportunistically. All probable HY KIMU were observed from 4 July −4 August with 28% recorded in the first survey period, followed by 11%, 17%, 17%, and 28%, respectively. Fourteen (89%) HY birds were observed in Taan Fjord and all HY murrelets were located within 984 feet (300 m) of shore.

Discussion and conclusions

KIMU densities estimated during this study are among the highest ever recorded for this species. Based on our results, the population in Icy Bay represents 5-14% of the estimated world population *(U.S. Fish and Wildlife Service 2004)*. Similarly, the variance estimates are astoundingly low compared to those calculated in Prince William Sound and Glacier Bay *(U. S. Fish and Wildlife Service 2004)*. Yet, the estimated population size of Kittlitz's murrelets in Icy Bay in 2002 was 2,098 ± 373 birds *(U.S. Fish and Wildlife Service, Juneau Field Office, unpublished data)* compared to the 2005 peak estimate of 1,317 ± 294 birds, suggesting a 37% decline over the three year period. However, abundance estimates varied dramatically among the five survey periods, suggesting that survey timing is critically important for ascertaining annual changes in abundance within glacial fjords.

Management implications

The factors that influence the spatial and temporal variability of KIMU should be considered when developing a monitoring program. Our results provide insight into this variability and allow us to make some recommendations for monitoring. First, monitoring surveys should occur during the first two weeks of July given the population peak during these periods. Second, the pelagic transect allowed us to account for variability across space that could not occur with shoreline transects. Yet a high degree of clumping will ultimately be a limiting factor in generating precise estimates of abundance. Given these considerations, our simulations and corresponding power analyses demonstrate that to detect an annual decline of 10% with a power of 0.9, we would need to monitor for 10-15 years *(Figure 2)*. We strongly suggest surveying annually in Icy Bay given the importance of this area for KIMU and lack of information about inter-annual variation. To do this, it would require conducting two bay-wide surveys (~65 km each) with two survey crews to reduce temporal variation.

Finally, our surveys suggested that generating productivity indices for KIMU is not feasible at this point. We identified a tremendous amount of variability in plumage characteristics that limited our ability to age birds on the water with confidence. Future work should focus on molt and plumage characteristics of different aged birds.

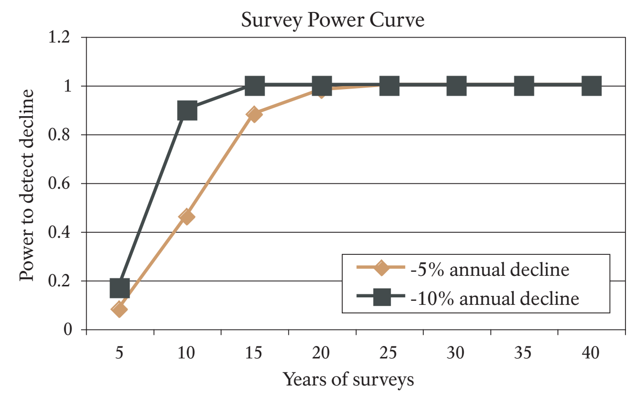

Figure 2. Results of power simulations designed to detect a decline of Kittlitz's murrelets in Icy Bay over a 5-40 year monitoring period given certain spatial variation and variability in detection probabilities.

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